Taylor Larrechea

Dr. Collins

PHYS - 252 HW 5

Problem 6.2

Numbers : (0.48), (0.45), (0.49), (0.46), (0.44), (0.57), (0.45), (0.47), (0.51), (0.50) in Volts

a.) With the use of excel,

Average : $\bar{x} = 0.48$

STDEV: $\sigma_x = 0.039$

$$\boxed{\begin{aligned}\bar{x} &= 0.48\,V \\ \sigma_x &= 0.04\,V\end{aligned}}$$

b.)

$$t_{sus} = \frac{x_{sus} - \bar{x}}{\sigma_x} = \frac{0.57 - 0.48}{0.04} = 2.25$$

$x_{sus} = 0.57$

$\bar{x} = 0.48$

$\sigma_x = 0.04$

$\text{prob(outside } 2.31\sigma) \equiv \alpha$

$$\text{prob(outside } 2.25\sigma) = 1 - \text{Prob(within } 2.25\sigma)$$
$$= 1 - 0.976$$
$$\alpha \approx 0.024 \qquad n = 10$$
$$n\alpha = 10 \times 0.024 = 0.24$$

Ten measurements

Since $0.24 < 0.50$, by chauvenet's criterion (0.57v) Should be thrown out in this experiment.

$\boxed{\text{Yes } 0.57v \text{ Should be thrown out}}$

Problem 6.4

Numbers: 11, 9, 13, 15, 8, 10, 5, 11, 9, 12, 12, 13, 9, 14 in (tracks/cm^2)

a.) With the use of excel,

Average : $\bar{x} = 10.786$ (tracks/cm^2)
STDEV : $\sigma_x = 2.665$ (tracks/cm^2)

$$\boxed{\begin{array}{l} \bar{x} = 10.786 \text{ (tracks/cm}^2) \\ \sigma_x = 2.665 \text{ (tracks/cm}^2) \end{array}}$$

b.) $x_{sus} = 5.000$ (tracks/cm^2)
$\bar{x} = 10.786$ (tracks/cm^2)
$\sigma_x = 2.665$ (tracks/cm^2)

$$t_{sus} = \frac{x_{sus} - \bar{x}}{\sigma_x} = \left| \frac{5.000 - 10.786}{2.665} \right| = 2.17 \qquad t_{sus} = 2.17\sigma$$

$$\text{prob(outside } 2.17\sigma) = 1 - \text{prob(within } 2.17\sigma)$$
$$= 1 - 0.970$$
$$\alpha = 0.030 \qquad n = 14$$
$$n\alpha = 14(0.030) = 0.42$$

Since $0.42 < 0.50$, by Chauvenets Criterion (5 tracks/cm^2) Should be thrown out.

$$\boxed{\text{Yes } 5 \left(\tfrac{\text{tracks}}{\text{cm}^2}\right) \text{ should be thrown out.}}$$

c.) Numbers: 11, 9, 13, 15, 8, 10, 11, 9, 12, 12, 13, 9, 14 in (tracks/cm^2)

With the use of excel,

Average : $\bar{x} = 11.231$ (tracks/cm^2)
STDEV : $\sigma_x = 2.166$ (tracks/cm^2)

$$\boxed{\begin{array}{l} \bar{x} = 11.231 \text{ (tracks/cm}^2) \\ \sigma_x = 2.166 \text{ (tracks/cm}^2) \end{array}}$$

Problem 7.1

$$\begin{array}{cccc} 1 & 2 & 3 & 4 \\ 1.4 \pm 0.5, & 1.2 \pm 0.2, & 1.0 \pm 0.25, & 1.3 \pm 0.2 \end{array} \text{ in (volts)}$$

weights : $w = 1/\sigma_x^2$

$$w_1 = \frac{1}{(\frac{1}{2})^2} = \frac{1}{\frac{1}{4}} = 4 \qquad w_2 = \frac{1}{(\frac{1}{5})^2} = \frac{1}{\frac{1}{25}} = 25$$

$$w_3 = \frac{1}{(\frac{1}{4})^2} = \frac{1}{\frac{1}{16}} = 16 \qquad w_4 = \frac{1}{(\frac{1}{5})^2} = \frac{1}{\frac{1}{25}} = 25$$

$$V_{wav} = \frac{\sum w_i R_i}{\sum w_i}$$

$$V_{wav} = \frac{(4\times 1.4) + (25\times 1.2) + (16\times 1.0) + (25\times 1.3)}{4+25+16+25} = 1.201 \text{ V}$$

$$V_{wav} = 1.20 \text{ V}$$

$$\sigma_{wav} = \frac{1}{\sqrt{\sum w_i}}$$

$$\sigma_{wav} = \frac{1}{(4+25+16+25)^{1/2}} = 0.119$$

$$\boxed{V = 1.20 \pm 0.1 \text{(V)}}$$

$$\sigma_{wav} = 0.12\text{V} \approx 0.1\text{V}$$

Problem 7.4

Numbers: $\overset{1}{503 \pm 10}$, $\overset{2}{491 \pm 8}$, $\overset{3}{625 \pm 20}$, $\overset{4}{570 \pm 40}$ in nm

a.)

$$x_{wav} = \frac{\sum w_i x_i}{\sum w_i}$$

$$w_1 = \frac{1}{(10)^2} = \frac{1}{100} = 0.01 \qquad w_3 = \frac{1}{(20)^2} = \frac{1}{400} = 0.0025$$

$$w_2 = \frac{1}{(8)^2} = \frac{1}{64} = 0.016 \qquad w_4 = \frac{1}{(40)^2} = \frac{1}{1600} = 0.000625$$

$$x_{wav} = \frac{(0.01 \cdot 503) + (\frac{1}{64} \cdot 491) + (0.0025 \cdot 525) + (0.000625 \cdot 570)}{0.01 + \frac{1}{64} + 0.0025 + 0.000625} = 499.8 \text{ (nm)}$$

$$x_{wav} = 500 \text{ nm}$$

$$\sigma_{wav} = \frac{1}{\sqrt{\sum w_i}}$$

$$\sigma_{wav} = \frac{1}{(0.01 + \frac{1}{64} + 0.0025 + 0.000625)^{\frac{1}{2}}} = 5.9 \text{ (nm)}$$

$$\sigma_{wav} = 5.9 \text{ (nm)}$$

$$\boxed{\lambda = 500 \pm 6 \text{ (nm)}}$$

b.) Disregarding (570 ± 40)

$\overset{1}{503 \pm 10}$, $\overset{2}{491 \pm 8}$, $\overset{3}{625 \pm 20}$

$$w_1 = \frac{1}{(10)^2} = \frac{1}{100} = 0.01 \qquad w_3 = \frac{1}{(20)^2} = \frac{1}{400} = 0.0025$$

$$w_2 = \frac{1}{(8)^2} = \frac{1}{64} = 0.016$$

$$x_{wav} = \frac{\sum w_i x_i}{\sum w_i} \qquad x_{wav} = \frac{(0.01)(503) + (\frac{1}{64})(491) + (0.0025)(525)}{0.01 + \frac{1}{64} + 0.0025} = 498.3 \text{ (nm)}$$

$$\sigma_{wav} = \frac{1}{\sqrt{\sum w_i}} \qquad \sigma_{wav} = \frac{1}{\sqrt{0.01 + \frac{1}{64} + 0.0025}} = 6.0 \text{ (nm)}$$

$$\lambda = 498 \pm 6 \text{ (nm)}$$

There is no change in uncertainty, but there is change in the best value. Therefore we can conclude that the last value is important. Therefore it is worth keeping.

$\boxed{\text{The last value is important}}$

Problem 7.5

Student A: $R = 72 \pm 8\ \Omega$ Student B: $R = 78 \pm 5\ \Omega$

a.) $X_{wav} = \dfrac{\sum w_i x_i}{\sum w_i}$ $\sigma_{wav} = \dfrac{1}{\sqrt{\sum w_i}}$

$w_A = \dfrac{1}{(8)^2} = \dfrac{1}{64}$ $w_B = \dfrac{1}{(5)^2} = \dfrac{1}{25}$

$$X_{wav} = \frac{(72 \cdot 1/64) + (78 \cdot 1/25)}{1/64 + 1/25} = 76.3\ \Omega$$

$$\sigma_{wav} = \frac{1}{\sqrt{1/64 + 1/25}} = 4.2\ \Omega$$

$\boxed{R_{wav} = 76 \pm 4\ \Omega}$

b.)

$SDOM = \dfrac{SD}{\sqrt{N}}$

Student B: $SDOM = \dfrac{\sigma}{\sqrt{N}}$ $\sigma = 5$ $N = 10$

$SDOM = \dfrac{5}{\sqrt{10}} = \dfrac{\sqrt{10}}{2}$

Student A: $\dfrac{\sqrt{10}}{2} = \dfrac{\sigma}{\sqrt{N}}$ $\sigma = 8$

$\sqrt{N} = \dfrac{2\sigma}{\sqrt{10}}$

$N = \dfrac{4\sigma^2}{10} = \dfrac{4(8)^2}{10} = \dfrac{256}{10} = 25.6 \approx 26$

$\boxed{\text{Roughly 26 measurements } N = 26}$